

PATHWAYS TO REVITALIZATION OF THE NAVY RESEARCH ENTERPRISE-- TWO PROMISING EXAMPLES

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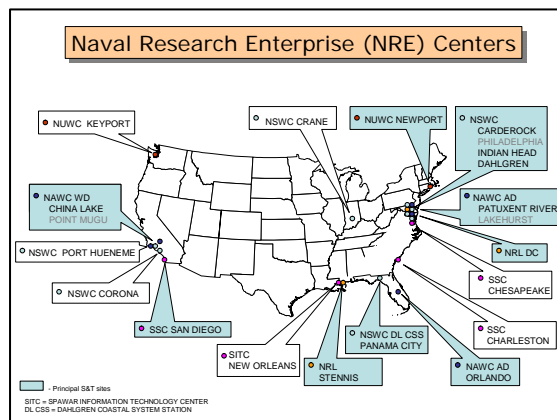
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Abstract

This paper describes two recent programs--the NSF Navy Civilian Service Program and the Virginia Demonstration Project that are dedicated to the revitalization of the Navy Research Enterprise.

Background

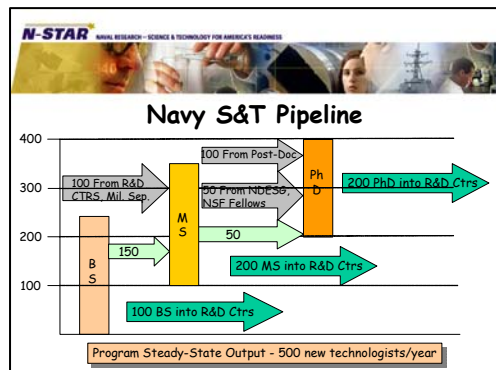
The Department of the Navy (DoN) is one of a growing number of Federal agencies which is expressing concern about its ability to meet its future science and technology (S&T) workforce needs. This situation has grown more critical in recent years due to the large numbers of retirements of S&T personnel expected in the coming decade because of the aging of the workforce, the decreasing number of US students pursuing advanced studies in engineering, and intensified recruiting of these students by industry, academia, and the government^{1,2}.



In 2002 Admiral Jay M. Cohen, DoN's Chief of Naval Research, and the leadership of the Naval Warfare Centers (NWCs), comprising the Naval Surface Warfare Center, the Naval Undersea Warfare Center, the Naval Air Warfare Center, and the Space Naval Warfare Systems Command, launched the Naval Research--Science and Technology for America's Readiness (N-STAR) program. This program, under the direction of the second author, has the goal of creating the intellectual capital base needed to develop the technology options for the "Navy-After-Next."

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Funded through the Office of Naval Research (ONR), N-STAR has begun to develop an integrated continuum of activities and programs that have as their ultimate goal recruiting 500 new scientists and engineers per year over the next ten years into the Naval Research Enterprise (NRE) which comprises the NWCs plus the Naval Research Laboratory.



The backbone of N-STAR consists of the Navy's ILIR (In-House Independent Research) and IAR (In-House Applied Research) programs. These programs are critical professional development enablers and annually provide the 2200 scientists and engineers who are working in S&T at the NWCs with competitive access to approximately \$20M of funding for basic and applied research.

In 2003, believing that the key to N-STAR's aggressive recruiting and retention goal, lies in strengthening DoN's research linkages with the Nation's leading universities in areas of mutual interest, ONR, in partnership with the National Science Foundation (NSF), launched the NSF Navy Civilian Service (NNCS) program. In 2004, in response to interest expressed by the Commonwealth of Virginia, the Virginia Demonstration Project (VDP) was added to the N-STAR program. The VDP is an outreach program which utilizes the S&T personnel of the Naval Surface Weapons Center Dahlgren Division (NSWCDD) as mentors in a program directed at increasing the level of interest in pursuing careers in science, mathematics, and engineering among seventh-graders in the communities adjacent to the Center. This paper will describe these two programs.

The NSF Navy Civilian Service (NNCS) Program

In this program, ONR, in partnership with NSF, seeks to revitalize the NRE by providing student scholarship, fellowship, and research support to the Nation's research universities to create with the NRE a collaborative educational and research environment which will contribute to the solution of problems of Navy interest and produce graduates who will work for the Navy upon graduation. The program supports promising graduate and undergraduate students in response to proposals submitted by university PIs and endorsed by the collaborating Navy center. The goal of the program is to create a collaborative DoN/university educational and research environment where university faculty members and students work together on cutting edge problems supported by the NWCs' world-class experts and facilities. This environment will help grow the pipeline of new talent that will positively effect the overall revitalization of the Navy S&T workforce.

Phase I of the NNCS program, a \$1M pilot program funded equally by NSF and the DoN, was begun in early 2004 and was focused on nanotechnology as the area of interest. The participants were chosen from proposals submitted by PIs currently supported by NSF's Nanoscale Interdisciplinary Research Teams (NIRT) and Nanoscale Science and Engineering Centers (NSEC) programs via the mechanism of NSF's *Dear Colleague Letter*.



National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Dear Colleague:

Introduction:

The National Science Foundation (NSF) and the Department of the Navy would like to call your attention to an opportunity for supplemental funding available within the area of nanotechnology for existing grant holders in the NIRT and NSEC programs.

NSF and the Navy jointly encourage proposals to fund students to participate in the jointly-funded NSF-Navy Civilian Service (NNCS) Fellowship-Scholarship Program. This program seeks students at the bachelors, masters, or doctoral level in science, technology, engineering and mathematics (STEM) who wish to commit a portion of their careers to serve at a navy R&D center.

The NNCS program has three goals. The program seeks to foster the production of a diverse additional group of US citizen STEM professionals with advanced degrees to secure the economic future of the nation. The program also seeks to foster stronger ties between the university research community and the Navy in order to apply the latest research in a more timely fashion. Finally, the program seeks to ensure the future of the research enterprise of the US Navy by providing new pathways for talented STEM professionals to enter careers at navy R&D centers.

Project Description:

This program seeks partnerships between navy R&D Centers and university NIRT and NSEC research groups. The university PI is responsible for partnering with a navy R&D center with an interest in similar research projects. The supplemental funding will provide up to two years of fellowship/scholarship support plus a cost of education allowance for eligible students to work in the PI's university lab. The students will be expected to work on a research topic under the direction of the PI on a problem of mutual interest to the PI and the navy R&D center. At the completion of their degrees, the students will be expected to go to work at a navy R&D center as civilian employees for one year for each year of support they receive.

The navy R&D center will be expected to provide at a minimum co-mentorship of the students (for graduate students, the navy mentor should serve on the student's thesis committee), and opportunities for the student to take a position at the navy R&D center of the mentor. Navy R&D center personnel participating in this program (center mentors) are to interact with the student and play an active role in the development of a student's research project and its execution. It is expected that a student will spend some portion of each calendar year working at the collaborating center via a summer internship or similar arrangement.

In addition to funding for students, the PI will receive the opportunity for close interaction with colleagues at Navy research facilities, opportunities for funded professional development, and the institution may receive compensation for administrative time spent on the award. Preference will be given to proposals with more comprehensive or innovative plans for the professional development of the student. For undergraduate students, integration of the research work with the student's curriculum is encouraged. A plan for a strong effort to recruit a highly qualified and diverse pool of students should be included in the proposal.

It is expected that grantee institutions will provide the infrastructure to recruit and support students, so that a sufficient number of fellowship/scholarship recipients will graduate. Such an infrastructure might include, for example:

- Recruitment of students, with special consideration to groups underrepresented in STEM fields (i.e., women, racial and ethnic minorities, and persons with disabilities);
- Academic support and mentoring to support students in making progress toward the degree and to prepare students for the workplace;
- Mechanisms to ensure retention of fellowship and scholarship recipients to degree completion.

Proposal Format:

NSF's Fastlane system should be used to prepare and submit these requests for supplemental funding (<http://www.fastlane.gov>). The Supplemental Funding Request can be accessed by the PI through the "Awards and Status" function, under the "Award and Reporting" functions. The PI should complete the Budget, Justification for Supplement, and Supplementary Docs sections of the Supplemental Funding Request according to the guidelines below.

This letter (left) announced the start of the NNCS program and outlined its goals. Details of the letter were finalized by a joint working group of NSF and ONR program officers and distributed in the late spring of 2004.

Eleven proposals were received. These proposals were then peer viewed by another group of NSF and ONR program officers, scientists, and engineers who selected five proposals for funding. Successful proposals provided evidence that the proposed research would be focused on problems of mutual interest to the universities and the NRE and that the educational experiences proposed for the students would include features which would cause them to look with favor upon permanent employment with the NRE upon graduation. The average proposal was funded at the \$250,000 level and covered a two-year period during which three students

(graduate and undergraduate) will receive full support in terms of tuition, room and board, fees, and stipend. In return for this support, the supported students must agree to work at a Navy center for two years upon their graduation.

The late official notification (mid-fall of 2004) of these awards to the winning universities resulted in some difficulty on the part of the university PIs in recruiting the promised number of students. Because of this, at the time of this writing only three student slots of the thirteen possible openings have been filled. It is expected that all of the remaining slots will be filled during the spring of 2005.

As these students move through their programs they will be tracked and evaluated, and the overall program will be assessed. The information on student progress and program operation will be evaluated by appropriate NSF and ONR personnel. With this information in hand, recommendations for the implementation of program improvements will be formulated. Among the issues requiring assessment are: 1) What difference has program made in terms of establishing a closer relationship between the Navy laboratories and the academic institutions with which they have been working? 2) What difference has this program made in terms of enhancing the laboratory's level of knowledge in critical areas? 3) What difference has the

program made in terms of contributing to technology transfer? 4) What difference has this program made in terms of attracting and increasing the diversity of the next generation of S&T leaders? and finally 5) What difference has this program made in terms of imparting to the students which it supports a positive view of the Navy as a career destination in both the near and far terms?

Improving the assessment process has already begun. One of the more difficult aspects of executing a scholarship/fellowship program for workforce revitalization is articulating the nature of the tracking, evaluation, and student assessment needs to potential participants in the program. The NNCS program officers used the assessment concepts found in the proposals funded in Phase I, along with personal experience and other resources to develop a clarified statement of assessment expectations which will be included in the announcement of Phase II of the program.

A \$3M Phase II of the NNCS is now underway, once again equally funded by the DoN and NSF. The intention of Phase II is to expand the disciplinary focus beyond nanotechnology to encompass a much broader spectrum of Navy interests. A new updated *Dear Colleague Letter* has been written and is currently in the process of being cleared for release by NSF. Once this letter has been approved, it will be sent to the relevant audience of current NSF PIs early in the spring of 2005. The intention of moving the release date of the new letter earlier in the year is to avoid the late announcement problems encountered in Phase I.

The NNCS will shortly have pages that will communicate on-going changes and improvements to the program as a component of the new N-STAR web site, www.nstarweb.com. One component will be a *Frequently Asked Questions* page that will focus on questions that potential new students might have about the program. Other pages will feature a list of on-going research projects of interest to the various NWCs along with the appropriate contact information to facilitate connections between prospective university PIs and NWC personnel. As mentioned previously, strengthening the connections between these two groups is an essential part of the NNCS model since this is viewed as being the ideal vehicle for producing the best science and engineering students and eventually recruiting them into the Navy civilian workforce.

During the initial meeting between NSF and the DoN leadership in November of 2003 that led to the establishment of the NNCS program, the funding levels which were discussed were in the range of ten to forty million dollars in order for NNCS to contribute to the N-STAR goal of filling the gap which will be produced by the anticipated retirement of 4,000 NWC scientists and engineers over the next decade. This, of course, is several times the current NNCS funding level. Ever tightening budgets at both organizations continue to present significant challenges in meeting this goal. For this reason, it was felt that another briefing to the new leadership at NSF and other stakeholders was important for the success of Phase II.

On 3 February 2005 a briefing occurred at the National Science Foundation on the current status of the NNCS program. Attending this briefing were the new director of NSF, Dr. Bement, his deputy, Dr. Bordogna, the Commander of Naval Research at ONR, Admiral Cohen, the Chief Scientist at ONR, Dr. Walker, a number of NSF Assistant Directors and other interested parties. This briefing gave the leadership of both organizations a chance to review the NNCS program, its progress to date and re-commit to the goals and resource requirements of the program. The

results of this briefing were very encouraging. Dr. Bement had indicated that budget pressures had caused him to cut a number of programs around NSF that were near the same level of funding as NNCS. However, because NSF believes so strongly in the goals of NNCS and the partnership with ONR, the NNCS program would not be cut. In fact, both organizations agreed to fund the \$3M Phase II effort as planned and to continue efforts to find additional funding. The new Dear Colleague Letter is in its final stages of NSF clearance and will be sent out in early March. Also, as a result of this briefing a number of other programs inside NSF are allowing their PIs to submit requests for supplemental funding under NNCS. These additional programs are: Engineering Research Centers (ERC), Science and Technology Centers (STC), Integrative Graduate Education and Research Traineeship Program (IGERT), and Information Technology Research (ITR).

The Virginia Demonstration Project (VDP)

Evidence gathered over the past decade points to the fact that the US is far from leading the industrialized world in preparing young people in the areas of natural science and engineering both in terms of numbers and quality. The US is surpassed in numbers by the United Kingdom, the Republic of Korea, Canada, Japan, and Taiwan,⁴ and surpassed in terms of the quality of eighth-grade level science and math skills by Singapore, Hungary, Latvia, the Russian Federation, Australia, and nine additional countries⁵.

Senator John Warner (R-VA) expressed the Commonwealth of Virginia's interest in these problems by introducing a \$2M supplement to ONR's budget to launch an outreach program in the communities located near the Naval Surface Weapon Center in Dahlgren, VA (NSWCDD). In 2004, the Virginia Demonstration Project (VDP) became the latest addition to the suite of N-STAR programs.

The VDP will use the S&T staff of NSWCDD as mentors in an outreach program directed at the six middle schools of Stafford County, Virginia, with the principal goal of generating the interest and enthusiasm of seventh graders in pursuing careers in science, engineering, and mathematics. Other objectives are to enlist the assistance of parents, teachers, and counselors in the support of this goal, to invigorate the science and math curricula, and to contribute to the professional development of middle-school science and mathematics teachers. Finally, through exposure to the NSWCDD staff as role models and the research conducted by the Center, the goal will be to increase the attraction of the Center as an eventual place of employment for the students participating in this program.

*"Experience to date has shown that students can be attracted to and retained in engineering programs if they are exposed early to the joys of creation through design, discovery through research and invention through hands-on experimentation."*³

The strategy of the program, as suggested in the quotation above, is to introduce the students to the essence of science, mathematics, and engineering by providing hands-on experiences. The VDP will culminate in a week-long summer academic camp which will feature involvement in hand-on projects directed at solving problems of Navy interest and visits to the Center's facilities.

Additional components of the program will include: 1) funding for Dahlgren scientists and engineers to spend one day per week during the academic year working in an outreach capacity to middle-school teachers and students, 2) opportunities for high-school, university, and community-college students to be involved in the summer portion of the program as mentors and role models, and, 3) funding for Dahlgren scientists and engineers to pursue a PhD at a Virginia university and, as a part of their responsibilities, to work with middle-school students and teachers as technical resources and role models. Also it is planned to provide leadership training for both students and teachers as a part of both portions of the program and a pre- and post-summer training period for teachers to familiarize them with the concepts and techniques of problem-centered learning. Finally, a strategy will be devised for keeping in touch with the students after the completion of the program to communicate information concerning science and mathematics competitions, leadership training, academic guidance, internship and scholarship possibilities, and relevant S&T career information.

Planning for the program began in September of 2004 with a meeting in Senator Warner's office of representatives of the project's partners: ONR, NSWCDD, the Stafford (VA) County Public Schools, the Stafford County Board of Supervisors, and the School of Education of The College of William and Mary. The College of William and Mary will coordinate the working relationships between the middle-school students, the teachers, and the Dahlgren scientists and engineers, as well as arrange for an assessment of the overall performance of the program.

Subsequent meetings have been held to begin laying out the details of the program. These have involved discussions for finding ways to: involve teachers and students in science and technology programs at NSWCDD; establish the procedures, policies, and metrics to ensure a successful long-term program throughout the local community; expose participants to the excitement and challenge of a career in science, technology, and engineering; provide teachers with on-going interaction and resources from the Navy and university resources including the use of problem-centered learning; and foster teacher leadership skills through their involvement in developing curriculum, providing staff development, and interacting with other professionals.

For the science and mathematics enrichment portion of the program, six teams consisting of two science and math teachers for each team will be selected representing all middle schools in Stafford County, along with all of the seventh-grade students in their classes. From this group 72 students and eight teachers will be selected to participate in the summer academic camp. Attention will be given to the selection of students for the summer camp to assure that students not yet demonstrating an interest in science and mathematics are included as well as students who represent an appropriate level of intellectual, cultural, racial, and economic diversity.

In preparation for the summer camp, a number of professional development days and planning sessions will be held that will include the teachers and the scientists and engineers. These will include sessions to orient teachers and the scientists and engineers to the purposes and techniques of for successful co-teaching, providing insight to the teachers regarding the creation and use of models for planning robotics missions, exchange of concepts and ideas on curriculum development, and information on the context of problem to be presented to the students. These sessions will also focus on cooperative learning, culturally sensitive teaching, and providing the

teachers and mentors with instruction on using the LabVIEW-based ROBOLAB programming language. The pre-summer effort will culminate in an “Expo” event at which the participating classes will present problem solving concepts based on learning objectives developed for the robotics problems. All the events will be captured on iMovie.

The academic summer camp will involve selected students in the hands-on solution of unmanned vehicle problems (including sensor and system integration issues) that are of current interest at the NSWCCD. The FIRST LEGO league (FLL), a highly-successful program which operates robotics competitions throughout the country devoted to providing middle-schoolers with a hands-on appreciation for the contributions of science and technology, will be used as the model for this part of the program. With the assistance of the Dahlgren mentors problem-based scenarios have been developed which we believe will be both interesting and challenging to the students, and, at the same time, will reflect current and projected Navy R&D requirements. Scientists and engineers have been selected from a number of Dahlgren research departments representing a cross-section of science and engineering disciplines to provide mentors for both the science and mathematics enrichment and the summer academic camp portions of this program. Care was taken in the selection of the mentors to assure a balance between the requisite technical skills and the necessary personal skills and awareness of Virginia’s Standards of Learning which are needed to interact with the students and teachers in a collaborative and supportive fashion. The summer camp will end with a motivational Challenge competition in which, in a sense, all of the competitors will be winners.

It is expected that the VDP will develop programs and strategies which can be extended to other states and to other NWCs. Special effort will therefore be given to documenting and developing the program so that such a scale-up and dissemination process can be facilitated.

The program will be carefully monitored and assessed in terms of providing on-going interaction with role models from the Navy and universities; strengthened peer, family, and school support for such interests; long-term inclusiveness of women and minorities in science and technology programs; increased numbers of students taking college-prep mathematics and science courses; increased teacher content knowledge and pedagogical knowledge in mathematics, science, and technology; and increased number of students receiving degrees in engineering, mathematics, and the physical sciences.

Conclusion

The programs described here involving partnerships with NSF, the College of William and Mary, and the Stafford County school system have features which promise to increase the interest of young people in pursuing careers in science and engineering and to enhance the training, recruitment, and retention of the future generation of the Navy’s S&T leadership.

We look forward to a future in which, stimulated by such programs as we have just described, a growth of interest in the young people of this nation in pursuing and persisting in careers in science, mathematics, and engineering occurs not only to assure our future economic and competitive well-being, but also to assure the future defense and security needs of the Nation.

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Biographical Information

EUGENE F. BROWN – Dr. Brown is Professor of Mechanical Engineering at Virginia Tech. He has worked with ONR since 2001 on university-centered Navy work force development issues. He teaches undergraduate and graduate courses in thermodynamics and fluid mechanics and is the author of many papers and reports describing his research in the areas of computational fluid dynamics and aircraft propulsion.

ROBERT A. KAVETSKY—Mr. Kavetsky is currently on a two-year assignment to ONR, where he is directing an initiative focused on revitalizing the S&T base in the Navy's Warfare Centers. He is a mechanical engineering graduate of Catholic University, and has worked in the fields of hypersonic aerodynamics, explosives, undersea warheads, and mine countermeasures.

ERNEST L. MCDUFFIE -- Dr. McDuffie is an assistant professor in the Department of Computer Science at the Florida State University and is currently on assignment to the Office of Naval Research, where he is deputy director of the N-STAR initiative. His career in federal service has included service as an electronic intelligence operations specialist for the National Security Agency and a program director for the National Science Foundation.

ROBERT L. STIEGLER -- Mr. Stiegler is currently supporting the USMC Targeting and Engagement Systems and the Office of Naval Research, N-STAR initiative. His recent career experience has included service as a program manager for USMC science and technology programs, Science Advisor to the Commanding General, Fleet Marine Forces Atlantic, and Head, NAVSEA Combat Systems Safety and Engineering Division.